

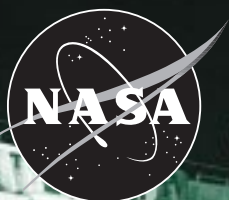
Aerospace Technology INNOVATION

Biotechnology Gets a Head Start

Slick Technology Helps Detect Oil

Earth to Orbits Could Be Cheaper

Wearable Computer in Prototype Stage



INNOVATION

Aerospace Technology

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About the Cover:

Construction of the International Space Station began in December 1988 when the U.S.-built Unity node was joined to the Russian-built Zarya module.

On-Line Edition: Go to <http://nctn.hq.nasa.gov> on the World Wide Web for current and past issues.

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COMMERCIAL DEVELOPMENT MISSION UPDATE

Date*	Flight	Payload	Sponsor/Coordinator
7/99	STS-93 AXAF	AEROGEL Commercial Generic Bioprocessing Apparatus-04**	Marshall Space Flight Center BioServe Space Technologies

Note: Sortie flights beyond STS-95, and Space Station Operations, under review at this time.

* As of November 1998.

** In combination with National Institutes of Health payload NIH-B1 in support of Life Sciences Division requirements.

Key STS—Space Transportation System, AXAF—Advanced X-ray Astrophysics Facility

WELCOME TO INNOVATION

NASA Biotechnology Science Program

By Dr. John M. Horack

Director of Science Communications

NASA Marshall Space Sciences Laboratory

IMAGINE BEING A SCIENTIST, BUT ONLY BEING able to go into your best laboratory for 10 days every year or so. The Space Shuttle is an excellent platform for biotechnology research, but it has to return to Earth after two weeks in space, along with the spaceborne laboratory and its outstanding and unique features for performing research. The NASA Microgravity Research Program's biotechnology discipline focuses on the development of new technologies to enhance current biological research and to open up new avenues of related research. As one of the most dynamic segments of our high-technology economy, biotechnology is playing an increasingly important role in medical research and the development of pharmaceutical drugs, agricultural research and products, environmental protection and many other important economic areas.

Biotechnology on Space Station—The International Space Station (ISS) is a setting for the autonomous function of more sophisticated research units that will allow NASA to conduct critical science experiments—24 hours a day, seven days a week. It will help science research and the imminent science and medicine applications in NASA's biotechnology program advance more quickly. A permanent, manned, operating laboratory in the microgravity environment of space will allow scientists to conduct a wide range of experiments, study them fundamentally and repeat and confirm basic hallmarks of scientific advancement—without having to wait for another Shuttle flight months or years later—culminating with quicker results. Biotechnology experiments aboard the ISS—including the growth of high-quality protein crystals, cell and tissue development and fundamental science—will be important in acquiring new knowledge and insight that will touch our lives in more ways than we can imagine. NASA's cell science program has focused on using bioreactors to simulate low-gravity conditions for the culture of cells to the extent possible on Earth. Research in this area will help establish the scientific basis for conducting culture experiments in the microgravity environment of space and contribute to culturing functional and differentiated tissues for medical treatment use—providing

an opportunity to recreate three-dimensional cell relationships important to normal organ function.

Protein Crystal Growth—U.S. Space Shuttle missions since 1985 have demonstrated that certain protein crystals grown in space are larger, have fewer defects and have greater internal order than their Earth-grown counterparts. The *Mir* science program provided the opportunity to grow protein crystals for longer periods. *Mir* helped shape investigations planned for the ISS and provided an early understanding of ISS operations. Information from high-quality, three-dimensional space-grown crystals reveals the structure or “blueprint” of the protein, providing key information that we cannot normally gain from poor-quality crystals grown on Earth. Many diseases involve proteins. Growing high-quality protein crystals for longer durations aboard the ISS will be significant in acquiring knowledge of important protein structures to help us prevent the spread of a disease. With more complete knowledge of just how that protein operates, we can attack the problems of disease systematically.

An Emerging Biotechnology—The ability to design a drug based on knowledge of a protein's structure is an emerging technology with enormous promise. Despite relatively good research success, the long time required to get a pharmaceutical to market has allowed only a few potential products to reach clinical trials and the final pre-market stages of development. Expanding this technology is required for a competitive advantage in biotechnology and to ensure NASA and U.S. leadership in providing cutting-edge research and technologies for space missions, technology transfer and commercialization. NASA's goal of obtaining a better understanding of how gravity affects crystal growth processes is important for achieving quality crystal growth both in flight and on the ground.

Applying Knowledge—NASA's goal is to exploit the unique microgravity environment of space to advance the understanding of fundamental processes, as well as use the information gained through space experimentation on a wide range of biotechnology applications. Gravity's effect on these processes can be virtually eliminated in space, thus allowing space-based experiments, coupled with ground-based experimental and theoretical research, to provide insights into biotechnological processes.

While basic research and the fundamentals of biotechnology are still of major importance to our program, there is shifting emphasis toward “mission-oriented” research—research aimed at specific problems in biotechnology applications on Earth as well as in the space environment. Thus, it is important that firmer links be developed between the research in support of the exploration of space and practical applications on Earth. ✱

TECHNOLOGY TRANSFER

Biotechnology Gets a Head Start

WHILE ASTRONAUTS ASSEMBLE AND ACTIVATE the first portion of the International Space Station (ISS), NASA scientists are preparing experiments that will take advantage of the most extensive space-based laboratory ever devised.

Biotechnology experiments are likely to be among the first microgravity science payloads aboard the ISS. In these experiments, protein crystals and cell cultures grown in space as part of the biotechnology program are analyzed on Earth. The experiments involving protein crystallization frequently return crystals with properties superior to those grown on Earth. These crystals are then used to determine the structures of molecules within the crystals. This information provides a better understanding of how the protein molecule works. These are the initial steps of a process called rational drug design, in which the knowledge of a molecule's structure is used in the development of drugs or treatments for diseases.

The Microgravity Science Glovebox offers more working space than the successful ones used aboard the Space Shuttle, Spacelab and Mir.



Cell cultures performed in space have shown differences with similar cultures performed on Earth. In some cases, the space-grown cultures exhibit properties more like those of cells found in the body than cells found in Earth-grown cultures. These differences can be used to better understand how the tissues of the body work without experimenting on human subjects. "Most of our current inventory of payloads can fly very early," said Patton Downey, NASA discipline scientist for microgravity biotechnology research, a discipline that has had great success with experiments aboard the Space Shuttle and Russia's *Mir* space station.

Most of the protein crystal growth hardware requires little of the ISS's resources and crew support. At most, they only need to be turned on and, days or months later, turned off. If crew time is available, some photo documentation may be requested.

Topping that list are payloads known as the Enhanced Gaseous Nitrogen Dewar and Diffusion Crystallization Apparatus for Microgravity. Each grows large quantities of crystals by slightly different techniques.

It is likely that these experiments will be conducted in an EXPRESS rack designed to handle experiments with minimal complexity, or in whatever space is available inside the Unity (Node 1) module, Zarya (the Russian-built base module) and other ISS elements as they are added.

"After that, the rotating Bioreactor experiments in cell science will start on one of the utilization flights," Downey said. The Bioreactor is more complex and will require some crew attention because the health and growth of the cell clusters inside must be monitored and the nutrient and waste bags replaced.

"What we would fly is much like what we flew on Russia's *Mir*," Downey said. "It would be self-contained with its own gas supply and other resources."

Extra Elbow Room

Many of the microgravity experiments planned for the ISS got their start—or an important boost—from early work in the Middeck Glovebox, a small enclosure carried aboard the Space Shuttle and *Mir*. In the glovebox, astronauts were able to conduct experiments that are highly promising but do not quite warrant a full-fledged facility of their own. They still need the personal touch.

Aboard the ISS, a larger, more capable Microgravity Science Glovebox (MSG) will be installed soon after the Laboratory module is launched. "It's going to be a little like pulling up to one of the workbenches in the laboratory here," said Charlie Baugher, MSG project scientist. "It'll have everything but the kitchen sink."

Services provided by the new glovebox will include electrical power, air conditioning (to clean the air and cool equipment), pressurized nitrogen, a vacuum vent, color video and connections to the ISS's own network and—through communications satellites and the Internet—to scientists at universities and government laboratories.

The new glovebox will be spacious. Scientists using the Middeck Glovebox had to cram experiments into containers about the size of a lunch pail, and then astronauts had to conduct the experiments in a volume just a little bigger than the lunch box. The MSG—with a large pull-out enclosure—will have openings 40 centimeters (16 inches) wide to accommodate experiments as large as a carry-on bag and more than enough room for astronauts to work around the apparatus.

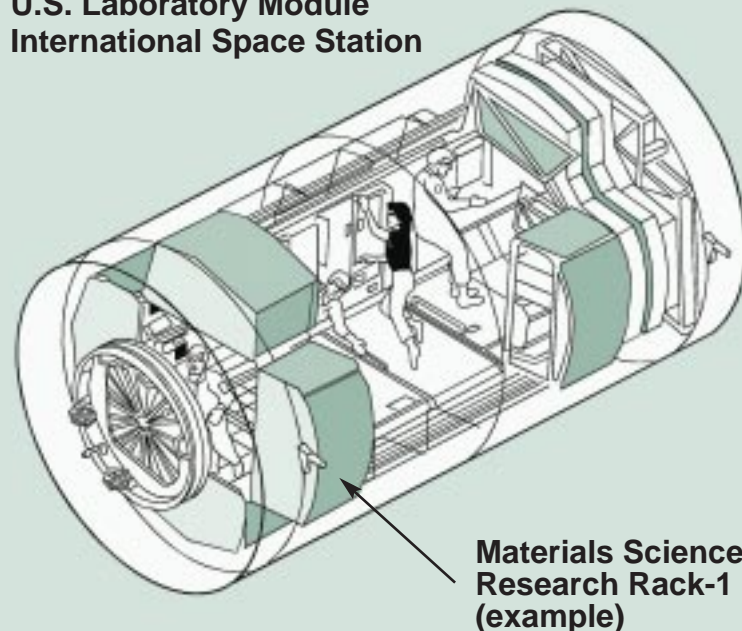
"The beauty of the MSG is that it is much more powerful than the original gloveboxes that scientists used and so more complete science can be done," said Dr. Don Gillies, the materials science discipline scientist.

On the Rack(s)

The MSG will be joined by the larger Materials Science Research Facility (MSRF), yet to be developed, and then integrated. The MSRF is a modular facility comprising three autonomous Materials Science Research Racks (MSRR) for research in the microgravity environment on the ISS and other equipment to conduct a wide variety of scientific investigations. Although they can be replaced in orbit, NASA envisions keeping the racks in place as long as possible and exchanging experiment systems within the racks. MSRR-1, scheduled for launch in October 2002, will host several modules developed by NASA and the European Space Agency (ESA), one of the major ISS partners.

The facility will provide the apparatus for satisfying near-term and long-range materials science discipline goals and objectives to be accomplished in the U.S. Laboratory. "It will handle a wide range of research in electronic crystals and advanced alloys," said Dr. Frank Szofran, MSRF project scientist.

U.S. Laboratory Module International Space Station



The left side of the rack will be filled with experiments provided by NASA's Space Product Development Program, which is working with industry to develop commercial applications in space processing. The Space Product Development Experiment Module (SPDEM), being developed by the Consortium for Materials Development in Space at the University of Alabama in Huntsville, will accommodate multiple furnace modules, including both transparent and opaque furnaces.

The right side will be filled with research equipment provided by NASA and ESA, which is also building its own laboratory, the Columbus Orbital Facility. NASA and ESA are each working on two module inserts for the first MSRR and will take turns using the rack.

The full range of experiments and their schedules are being developed by NASA and its partners. They deliberately avoided locking the experiments in place because science usually moves at an unpredictable rate, and today's discoveries can redirect tomorrow's plans. ✨

A cutaway view of the U.S. Laboratory showing several of the Materials Science Research Racks.

For more information, contact Patton Downey at NASA Headquarters.

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Please mention you read about it in *Innovation*.

Space Shuttle Leak Detector Commercialized

AN ELMSFORD, NEW YORK, COMPANY specializing in leak detectors for pressurized cable is successfully commercializing an improved and more efficient ultrasonic leak detector. This new detector is based on technology developed in late 1990 to detect hazardous fluid leaks in the Space Shuttle fleet grounded at Kennedy Space Center.

A local and international supplier for local and international telephone companies, UE Systems Inc. offers an improved product that is a plug-in module for the firm's existing product line called the Ultraprobe™. The portable, handheld ultrasonic instrument detects compressed air leaks in cables and fittings, above ground and in vaults, transmitting very low-level ultrasound energy to the apex of a sensitive transducer in the device.

The unique parabolic-shaped collection horn gathers ultrasound from a distant leak source and helps screen out background noises. The parabolic design of the amplifying chamber reflects all signals directly to the transducer with minimal acoustic energy loss.

The signal from the transducer is preamplified and transferred to the Ultraprobe™ housing, where it is amplified again. The captured audio signal is then sent to headphones or a spectrum analyzer for further analysis or data storage. This "double amplification" effect works acoustically like a telescope and magnifies the leak for easier detection.

Instead of producing an entirely new instrument, UE Systems utilized NASA's innovative circuitry, improved transducers and unique collecting horn to create the highly reliable, versatile and sensitive plug-in module. The unit is small, lightweight and rugged compared to other systems and doubles the distance a leak is detectable. The user can remain safely on the ground while scanning overhead lines and other inaccessible areas for otherwise undetectable leaks.

The ultrasonic instrument provides testing capabilities that range from simple leak detection to more complex mechanical analysis. "Compressed air leak detection at a distance, electrical connections on overhead power transmission lines and pressurized overhead telephone cables are a few of the primary applications to use the [plug-in] module," stated Terrence O'Hanlon, UE Systems president.

NASA and the military are using the new detectors to find leaks on flight hardware and in fuel tank tests, as well as ground support equipment for future Shuttle missions. Using the improved leak detector could save U.S. manufacturers thousands of dollars in energy costs by minimizing the waste of energy associated with compressed air systems up to this point.

When STS-35 and STS-38 were grounded, Kennedy Space Center engineers developed new ultrasonic leak detectors to search for leaks in critical launch and ground support equipment and in the aft engine compartments. The leaks were found and fixed. Further enhancements were later made, and the detectors were used to find leaks in the solid rocket boosters. ✱

For more information, contact Lewis Parrish at Kennedy Space Center. ☎ 407/867-6373, ✉ ParrilM@kscgws00.ksc.nasa.gov Please mention you read about it in *Innovation*.

A leak detector developed for the grounded Space Shuttle fleet in 1990 has been enhanced many times. The most current is an ultrasonic handheld plug-in model marketed widely, quickly and inexpensively.



The First of Earth Science's New Initiatives

NASA HAS SELECTED NINE INSTITUTIONS FOR the first of many initiatives that will utilize a decade's worth of Earth science research and data to solve and mitigate large-scale practical and societal problems. Seven Regional Earth Science Applications Centers (RESACs) will use NASA's Earth science results, technologies and data products to help resolve issues with regional economic and policy sig-

nificance and to support regional assessments supporting the U.S. Global Change Research Program. The RESACs are formed by nine public/private consortia from throughout the United States.

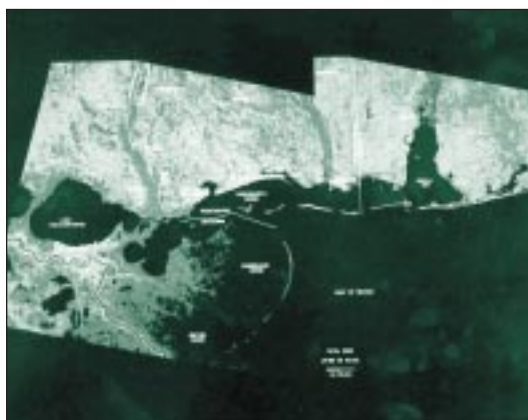
The RESACs will apply state-of-the-art NASA Earth science research results to such diverse areas as precision farm management, forest growth and health monitoring, regional water resources and hydrology, impact assessment of long-term climate variability and change, land cover and land use mapping, agricultural crop disease and infestation detection, fire hazards management, watershed and coastal management, environmental monitoring and primary and secondary science education.

The centers, selected by NASA's Office of Earth Science, will be composed of "end-to-end" consortia (from defining user needs to product delivery) and will include members from the research community, private industry, public agencies and other potential information users in the public and private sectors. The selected consortia involve more than 20 private companies, about 10 state and local government agencies, 20 federal agency regional offices and 15 universities.

One RESAC will address water management problems in the arid southwestern United States. Using hydrologic models derived from NASA-sponsored research, the RESAC will use spaceborne and airborne instruments to provide improved information on water resource availability. This information will assist planners in developing strategies for resource allocation among competing economic and environmental uses in a rapidly evolving global economy.

"Regional-scale problems are well suited to NASA's Earth science data and technology. No other system of observation is available for analyzing such large-scale issues," said Dr. Ghassem Asrar, Associate Administrator for Earth Science at NASA Headquarters in Washington, D.C. "This program will capitalize on the science and technology developed over the past decade by NASA's Earth Science Enterprise to provide solutions to practical and societal problems that exist today and help in mitigating them in the future."

"The selection of the RESACs is the first of a number of planned NASA initiatives to develop new methods for bringing together the research, service and user communities to apply NASA's research results to practical, near-term problems," added Alex Tuyahov, manager of the Earth Science Applications Research Program at NASA Headquarters.



NASA-selected consortia will use remote sensing to provide solutions to large-scale economical, environmental and societal issues and problems through Landsat images such as this one of the Louisiana/Mississippi gulf coast area.

The three-year grants for RESACs will utilize NASA's extensive Earth science program, a long-term effort to study human-induced and natural changes in the whole Earth system. ✱

For more information, contact David E. Steitz at NASA Headquarters.

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Please mention you read about it in *Innovation*.

Mini Transmitter Saves Babies

A NASA-DEVELOPED "PILL TRANSMITTER" IS expected to begin monitoring mothers and their babies following corrective fetal surgery for body temperature, pressure and other vital signs in the womb and then radioing physicians this critical information. An even smaller pill that can be swallowed by astronauts to track vital signs during space travel will be developed later.

Ames Research Center, Moffett Field, California, developed the pill in cooperation with the Fetal Treatment Center at the University of California at San Francisco. "If you implant our pill, doctors are able to monitor the magnitude and frequency of contractions to enable physicians to identify the onset of preterm labor early enough to prevent it from becoming life threatening to the fetus," said Dr. Carsten Mundt, an electrical engineer on the Sensors 2000! team at Ames.

Mundt also said preterm labor is difficult to predict and monitor with conventional equipment. Nearly every fetal surgery results in preterm labor that, if left untreated, can lead to the baby's death, according to Mundt.

TECHNOLOGY TRANSFER

The surgeons at the University of California at San Francisco have recently begun using an endoscopic technique for these corrective surgeries to minimize the risk of inducing preterm labor. In this technique, small incisions are made, and tube-like devices called endoscopes are inserted through the mother's abdominal wall. Prior to this technique, pediatric surgeons at the Fetal Treatment Center pioneered a cesarean surgical approach to implant a larger sensor-transmitter for monitoring mothers and fetuses. In 1981, Michael Harrison, M.D., the Fetal Treatment Center's founding director, performed the world's first corrective fetal surgery.

The pill, about one-third of an inch across and one and a third inches long, was developed because sensor-transmitters small enough to fit through the endoscopic surgery tubes were not commercially available. For ulcer patients, pills could monitor intestinal pressure changes and stomach acidity. Smaller pills, currently in development, will transmit fetal heart data and measurements for fetal body chemicals, including ionic calcium, carbon dioxide and glucose, according to Sensors 2000! scientist Dr. Chris Soms at Ames.

"We would also like to use this technology to study what happens to astronauts during space travel," said Ames team member Mike Skidmore. "Not only could they swallow the smaller pill transmitters we plan to develop, but we have a conceptual design of small, flat transmitters that can be taped to the body like plastic bandages."

There are many possible medical uses for this technology. A prototype version of another pill to

measure and transmit pH, or acidity, in the fetus is being tested by Ames scientists. ✱

For more information, contact Mike Skidmore, Deputy Manager, Sensors 2000! Program, at Ames Research Center. ☎ 650/604-6069, 📠 650/961-8472, ✉ mskidmore@mail.arc.nasa.gov Please mention you read about it in *Innovation*.

MICROGRAVITY RESEARCH GRANTS ANNOUNCED

The majority of research supported under microgravity biotechnology research grants recently announced by NASA includes 34 new research efforts and continuation of work currently funded by NASA. The protein crystallization, cell science studies and new technology development may affect areas in structure-based drug design, tissue engineering and biosensor development.

NASA has selected 48 researchers to receive grants to conduct microgravity biotechnology research. Sponsored by NASA's Office of Life and Microgravity Sciences and Applications, this research allows investigators to take advantage of a low-gravity environment to improve understanding of fundamental physical and chemical processes associated with biotechnology. Of these grants, 40 are to conduct ground-based research, while the remaining 8 are flight definition efforts. The investigators will have NASA's microgravity research facilities at their disposal, such as aircraft flying parabolic trajectories and sounding rockets. The flight definition investigators will work toward experiments on the International Space Station.

NASA received 165 proposals that were peer-reviewed by scientific and technical experts from academia, government and industry. In addition, those proposals selected for flight definition were reviewed in terms of engineering feasibility by a team from NASA's Marshall Space Flight Center in Huntsville, Alabama. A list of awardees can be found at: <ftp://ftp.hq.nasa.gov/pub/pao/pressrel/1998/98-217a.txt> ✱

For more information, contact Renee N. Juhans at NASA Headquarters. ☎ 202/358-1712, 📠 202/358-4210, ✉ rjuhans@hq.nasa.gov Please mention you read about it in *Innovation*.

This pill-shaped transmitter, with other versions in development, passes through endoscopic tubes to radio critical information to physicians from mothers and their babies following corrective fetal surgery.



ADVANCED TECHNOLOGIES

Slick Technology Helps Detect Oil

NASA IS TEAMING WITH INDUSTRY TO IDENTIFY marine oil seeps to offer clues on oil deposits. This can save companies millions of dollars in unnecessary ocean surveys.

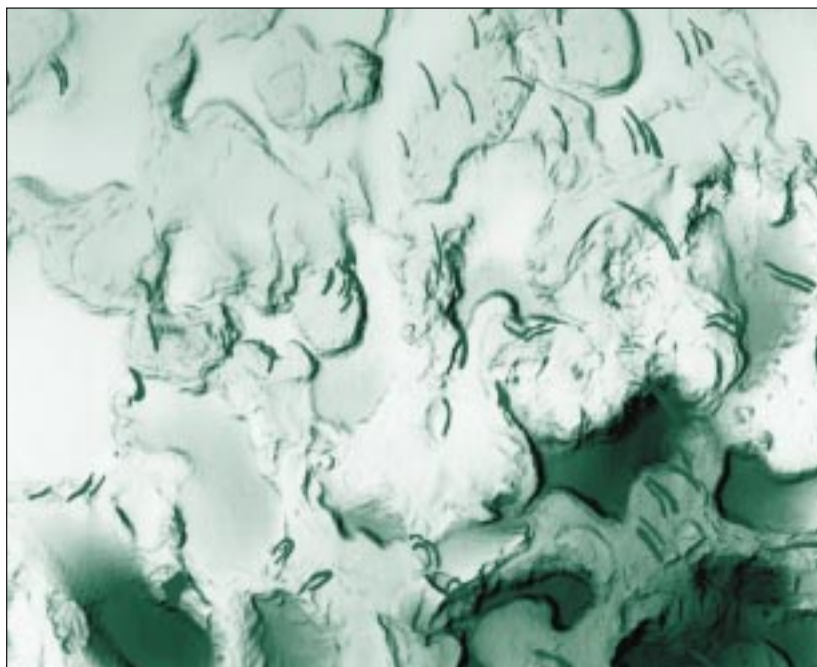
The Commercial Remote Sensing Program at John C. Stennis Space Center in Mississippi is working with a Rockville, Maryland, company. Through the Earth Observation Commercial Applications Program (EOCAP) at Stennis, the Earth Satellite Corporation (EarthSat) is using remote-sensing technology to help identify the oil seeps in the Gulf of Mexico.

"Oil seep detection is a market that has not been addressed by any other EOCAP partnerships," said Mark Mick, EOCAP manager at Stennis. "I also think it is a good application for remote-sensing technology."

Remote sensing uses sensors mounted on aircraft or satellites to look at Earth's surface. Oil migrates naturally through cracks from deposits deep below the ocean floor, releasing oil into the world's surface waters. These marine oil seeps offer clues as to where oil deposits may be located in ocean basins. Marine oil seeps occur naturally and are manifest as oil slicks on the ocean's surface.

To detect oil seeps, EarthSat uses radar satellite data from RadarSat International, a joint NASA-Canadian Space Agency mission in Richmond, British Columbia, Canada, and at times from radar data of the European Space Agency and the U.S. Landsat Thematic Mapper. The radar data measure changes in the texture of the ocean surface, which differs noticeably if an oil slick is present. The very thin oil layer on the water dampens the small (capillary) waves, making the radar image appear dark. Oil companies may use this information to identify areas with potential hydrocarbon deposits and plan their seismic exploratory activities.

The advantages to companies of EarthSat's spaceborne radar survey technique are that it is less expensive than aerial surveys and it allows oil companies to concentrate their explorations in areas that are most likely to be rich in oil. A satellite survey of an area of the ocean costs tens of thousands of dollars, while a typical seismic survey



This two-dimensional sun-shaded relief of Green Canyon sea floor shows oil slicks overlain on top.

has a price tag of hundreds of millions of dollars. "If you find oil seeping out of the ocean floor, it makes the decision to spend millions of dollars on a seismic survey much easier," Roger Mitchell, EarthSat vice president, said. ✱

For more information, contact Lane Cooksey at Stennis Space Center.

☎ 228/688-3341. Please mention you read about it in *Innovation*.

Cameras "Eye-ing" Full Capacity Airport

NEW DIGITAL VIDEO CAMERAS INSTALLED BY NASA at the San Carlos, California, airport control tower are helping to better report current weather conditions for aircraft landing at San Francisco International Airport, some 10 miles away.

Installed by engineers from NASA's Ames Research Center, Moffett Field, California, the Airport Approach Zone Camera System enables air traffic controllers and weather forecasters to track the real-time onset and dissipation of fog and low clouds in the airport's approach zone, particularly during the late morning. Because many aircraft arrive at that time, the precise timing of the

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improved visibility will improve the airport's ability to operate at, or close to, full capacity.

"The big problem with arrivals at San Francisco International Airport is that the runways are only 750 feet apart; when you can't use both runways at the same time, you can only land 30 aircraft an hour," said Yuri Gawdiak, an Ames aerospace engineer and the project leader. San Francisco International Airport is one of the nation's busiest, with 600 to 700 landings on a typical day. With both runways operating simultaneously, 60 aircraft an hour can land.

"The live pictures allow us to better serve the needs of the Federal Aviation Administration's (FAA) air traffic management specialists here at the Oakland Air Route Traffic Control Center in Fremont, California, the Oakland Bay TRACON (Terminal Radar Approach Control Facility) at the Oakland International Airport, and the Air Traffic Control System Command Center in Washington, D.C.," said Walt Strach, National Weather Service meteorologist in charge of the Fremont facility.

The Airport Approach Zone Camera System will significantly reduce telephone calls between the FAA Oakland Center meteorologist and the San

Francisco air traffic control tower. "This should translate into more efficient procedures for flow control when weather is a factor in landing aircraft at San Francisco International Airport," Strach said.

"The Airport Approach Zone Camera System is allowing meteorologists, both in my office and at the National Weather Service Forecast Office in Monterey, California, to better see and understand the local effects of wind currents and terrain, ocean and bay influences on the formation and dissipation of clouds and fog in and around San Francisco International Airport," Strach said. The Monterey weather office issues aviation, public and marine forecasts for the entire San Francisco Bay Area.

The high-speed video cameras operate 24 hours a day and provide a 220-degree field of view with rotation, zoom and tilt capabilities. Personnel in the National Oceanic and Atmospheric Administration (NOAA) weather center located at the Oakland Air Route Traffic Control Center remotely control the cameras, which also are accessible via a secure web site. Ames engineers will install similar cameras at the San Francisco International Airport control tower in the near future.

HUBBLE DATA PHONED FROM HOME

Computer software developed for NASA's Hubble Space Telescope will soon help operate a worldwide, satellite-based phone system called Globalstar. This software is a key feature of NASA Goddard Space Flight Center's "Vision 2000," an ongoing effort to optimize the ground system operations and control of the Hubble Space Telescope. The "Vision 2000" software allows scientists and engineers to access and display Hubble spacecraft and ground systems data through the Internet. Now engineers can log on from home or other remote locations via their personal computers.

This Hubble spinoff will provide Globalstar, LP, San Jose, California, with the technology to aid in delivering voice, data, fax and other telecommunications services to users worldwide and satisfies the critical need for Globalstar engineers to remotely access spacecraft telemetry data from anywhere in the world. Globalstar team members and partners will be able to coordinate efforts and dynamically monitor and troubleshoot situations with the constellation of 48 low-Earth orbiting satellites from multiple locations.

As part of its mission to build technology partnerships with industry, Goddard, in Greenbelt, Maryland, where the Hubble Space Telescope is controlled, has authorized Lockheed Martin Technology Services Group, Seabrook, Maryland, to use this software for the commercial Globalstar project. Lockheed Martin Technology Services Group is a ground systems contractor to Globalstar, LP. Goddard is in the process of evaluating the software to determine other viable commercial applications. ✱

For more information, contact Nancy Neal at Goddard Space Flight Center. ☎ 301/286-0039, 📠 301/286-1707, ✉ Nancy.g.neal.1@gsfc.nasa.gov Please mention you read about it in *Innovation*.

The Airport Approach Zone Camera System is a joint effort among Ames, the FAA and NOAA. The project is managed by the aviation safety monitoring office at Ames and funded by NASA's Aviation Safety Program. ✱

For more information, contact Yuri Gawdiak at Ames Research Center.

☎ 650/604-4765, ✉ ygawdiak@mail.arc.nasa.gov Please mention you read about it in *Innovation*.

New Concept for Technology Commercialization

NASA RECENTLY ANNOUNCED A WORLD-CLASS concept for a 21st century complex for research, development, education and partnerships for commercializing NASA technology. The complex will be located at Ames Research Center, Moffett Field, California.

This new Ames Research Complex will be a world-class, shared-use, research and development campus in conjunction with local communities. It will involve partnerships with government, academia, private industry and nonprofit organizations to educate and inspire America's children, to develop the next-generation of engineers and scientists and to enhance both the well-being of our communities and life in America in the 21st century.

The complex will ultimately encompass the 2,000-acre Ames property and will feature partnerships in astrobiology, aerospace, information technology, education and commercialization of NASA technology—all key elements of the mission of Ames Research Center within NASA. These collaborations will strengthen technological leadership, demonstrate the strength of government, industry and academia working together and serve as an exciting centerpiece for other partnerships.

Partnering is the key to the emergence of tomorrow's required innovations needed to enhance life today and into the 21st century, according to NASA Administrator Daniel S. Goldin. "They will come from all of us working together and making the most of the special attributes that each of us brings to the table. NASA is committed to do that here at Ames," he said.

Preliminary negotiations with industry, government and academia have begun. Within the next year, partnership agreements with potential onsite research collaborators are expected to be finalized, said Henry McDonald, Ames Research Center Director.

Agreements have been established with the cities of Mountain View and Sunnyvale, which have already established an independent, nonprofit foundation board to oversee a key feature of the new complex—the California Air and Space Center (CASC), a nonprofit education organization—according to McDonald. Stanford University and the University of California at Santa Cruz are set for research partnership planning.

The initial development of the complex will focus on a 160-acre parcel on the west side of the airfield, which will be "opened up" to allow public and easy access with no security badging requirements

to provide opportunities for collaborative research and education facilities and allow for large-scale events. Along with the CASC, the Computer History Museum will be a nonprofit education partner for the public.

Historic Hangar 1 will be converted into a

dynamic science and technology learning center supported by futuristic NASA technologies. It will showcase Silicon Valley cutting-edge technologies, NASA missions and a teacher institute. A number of Bay Area universities and California education officials have expressed interest in partnering to design the teacher institute. ✱

For more information, contact Michael Marlaire at Ames Research Center.

☎ 650/604-4190, ✉ mmarlaire@mail.arc.nasa.gov Please mention you read about it in *Innovation*.

AEROSPACE TECHNOLOGY DEVELOPMENT

Earth to Orbits Could Be Cheaper

THE FIRST IN A CONTINUOUS SERIES OF flight demonstrators called "Future-X," under the Advanced Technology Vehicle (ATV) program, could soon begin industry- and NASA-led technology experiments. The goals are to increase U.S. competitiveness in the worldwide commercial space transportation market and to decrease future government costs for space access.

NASA has selected the Boeing Company of Downey, California, for negotiations leading to a possible award of a four-year cooperative agreement to develop the first of the Future-X ATV vehicles. Depending on successful negotiations, work under the cooperative agreement could begin immediately, and alternative designs are available for NASA selection, pending negotiation results.

Future-X vehicles and flight experiments will demonstrate technologies that improve performance and reduce development, production and operating costs of future Earth-to-orbit and in-space transportation systems. Technologies tested through Future-X also will help industry and NASA develop and build future generations of space launch vehicles that are more advanced and cheaper than previous vehicles.

Under the 50-50 cooperative agreement, valued at \$150 million, Boeing and NASA would advance 29 separate space transportation technologies through development and flight demonstrations. This modular orbital flight would be the first-ever experimental vehicle to be flown in both orbital and reentry environments. NASA is pursuing technologies that will benefit both military and commercial aerospace.

Three companies and three NASA research centers were selected to provide the flight demonstrator and flight experiments from a total of 50 proposals submitted in response to a NASA Research Announcement with a total estimated value of \$24 million. The Space Transportation Programs Office at NASA's Marshall Space Flight Center in Huntsville, Alabama, will manage the Future-X effort.

The companies selected are Southwest Research Institute, San Antonio, Texas; Draper Laboratory, Cambridge, Massachusetts; and AeroAstro, Herndon, Virginia. In addition to Marshall, NASA centers selected include Ames Research Center, Moffett Field, California, and Lewis Research Center, Cleveland, Ohio.

Selected industry-led experiments include a hall-effect thruster system flight demonstration of new on-board in-space propulsion technologies, an experiment to demonstrate an on-board intelligence planning system for autonomous abort landings and an experiment to demonstrate technologies that will significantly reduce the access-to-space costs of small payloads. Selected NASA-led experiments with substantial industry involvement include experiments to demonstrate advanced technologies of an integrated-vehicle health management system and ultrahigh temperature ceramics for reusable, sharp hypersonic leading edges, an experiment to demonstrate propulsion technologies that will reduce the weight and size of advanced cryogenic upper stages and an experiment to demonstrate advanced propellantless, in-space propulsion technologies through an electrodynamic tether that works as a thruster. ✨

For more information, contact John London at Marshall Space Flight Center.

☎ 256/544-0914, ✉ john.london@msfc.nasa.gov Or contact Dennis Smith at Marshall. ☎ 256/544-9119, ✉ dennis.e.smith@msfc.nasa.gov

Please mention you read about it in *Innovation*.

Documented ER-2 Altitude Sets World Record

A NASA ER-2 AIRCRAFT RECENTLY SET A NEW world altitude record for medium-weight aircraft by reaching 68,700 feet, almost twice the cruising altitude of most airliners, during an airborne science mission. The purpose of the mission was to measure different components in the atmosphere, such as water, ozone and other atmospheric particles.

A contract in negotiations with Boeing for the Future-X flight demonstrator could lead to experiments of cutting-edge technologies to increase U.S. competitiveness in the commercial space market.



This was not the first time the ER-2 has achieved such a high altitude, but it is the first time the ER-2's performance has been documented and made public. The ER-2, tail number 806, based at Dryden Flight Research Center, Edwards, California, and a close relative of the U.S. Air Force U-2, routinely operates between 65,000 and 70,000 feet.

The new record set by the ER-2 surpassed the old record of 62,500 feet, which was flown by a Canadian P-42 aircraft in 1988. The record was for the aircraft medium-weight class of 26,455 to 35,274 pounds at takeoff.

An official from the National Aeronautics Association, the organization responsible for the coordination and certification of all aviation records in the United States, observed the record-setting event. A formal certification will be processed with Federal Aeronautique Internationale, an international organization responsible for the coordination of competition and certification of all world aviation records.

Two ER-2 aircraft are owned and operated by NASA for its Airborne Science Program. Built by the Lockheed Martin Skunk Works, the aircraft collect information about our surroundings, including Earth resources, celestial observations, atmospheric chemistry and dynamics, and oceanic processes. The aircraft also are used for electronic sensor research and development, satellite calibration and satellite data validation.

The NASA ER-2 recently concluded a six-week hurricane study originating from Patrick Air Force Base in Florida. The study was designed to improve scientists' ability to forecast, track and measure the intensity of hurricanes, collecting valuable information that could ultimately save lives and money.

The ER-2 can reach an altitude of 65,000 feet within 20 minutes, depending on aircraft weight. A normal six-hour mission is approximately 2,500 miles at 470 miles per hour, yielding about five hours of high-altitude data. Missions of more than eight hours and 3,400 miles are possible for the aircraft. Maximum payload is 2,600 pounds.

NASA acquired its first ER-2 aircraft in 1981 and then a second in 1989, replacing two Lockheed U-2 aircraft used by NASA since 1971. NASA has used these aircraft to collect science data during more than 4,000 data missions and test flights in support of scientific research conducted by scientists from NASA, other government agencies, universities and the private sector. The U-2s, and later the ER-2s,



The NASA ER-2 aircraft, tail number 806, was officially documented as cruising almost twice the altitude (68,700 feet) of most airliners.

were based at NASA's Ames Research Center, Moffett Field, California, until 1997, when the ER-2s and their operations moved to Dryden. ✱

For more information, contact Larry Montoya at Dryden Flight Research Center. ☎ 805/258-2775, ✉ Larry.Montoya@dfrc.nasa.gov Please mention you read about it in *Innovation*.

X-36 Tests to Demonstrate More Benefits

ADVANCED FLIGHT SOFTWARE TESTS ON the NASA/Boeing X-36 Tailless Fighter Agility Research Aircraft will demonstrate technology designed to increase aircraft survivability and significantly reduce the life-cycle costs of military and commercial aircraft.

The Reconfigurable Control for Tailless Fighter Aircraft (RESTORE) program will use advanced flight control software to respond to a variety of battle damage and hardware failures during testing conducted at NASA's Dryden Flight Research Center, Edwards, California, by the Air Force Research Laboratory of Wright Patterson Air Force Base in Dayton, Ohio. During the RESTORE program, the Air Force will fly the remotely piloted X-36 aircraft using neural network software to provide flight control reconfiguration during simulated damage in flight.

Control of the X-36 was transferred to Dryden from NASA's Ames Research Center, Moffett Field, California, where NASA completed its X-36 flight research program in November 1997. The program

AEROSPACE TECHNOLOGY DEVELOPMENT



Cutting-edge technologies that will increase U.S. competitiveness in the commercial space market will be demonstrated through the X-36 program and flight experiments. Future flight tests for the X-36 tailless fighter aircraft will occur at Dryden Flight Research Center.

successfully demonstrated the feasibility of future tailless fighters to achieve agility levels superior to today's best military fighter aircraft.

The RESTORE flight tests are a joint effort funded by NASA, the Air Force Research Laboratory and the Naval Air Systems Command (NAVAIR), Patuxent River, Maryland. The Boeing Company owns the X-36 aircraft, and the company's Phantom Works division is developing the RESTORE technology.

During the original X-36 flight research program at Dryden, 31 flights were made in only 25 weeks in 1997, for a total 15 hours, 38 minutes, and using four flight control software versions. The aircraft reached an altitude of 20,200 feet and a maximum angle of attack of 40 degrees. A pilot in a ground station cockpit, complete with a head-up display, remotely controls the aircraft. This eliminates the need for expensive and complex autonomous flight control systems.

Built by the Boeing Company Phantom Works in St. Louis, Missouri, the 28-percent-scale X-36 is designed to fly without the traditional tail surfaces common on most aircraft. The X-36 is 18 feet long, has a 10-foot wingspan, is three feet high and weighs 1,270 pounds. It is powered by a F112 turbofan engine, which provides 700 pounds of thrust and was developed by Williams International Corp., Inc., of Walled Lake, Michigan.

Ames and the Boeing Company Phantom Works developed the technologies required for a tailless fighter beginning in 1989, and a technology demonstration was proposed in 1993. In 1994, Phantom Works began fabrication of the two aircraft in its rapid prototyping facility in St. Louis. The aircraft was designed and built in only 28 months. NASA and Boeing were full partners in the program, which was jointly funded under a roughly 50-50 cost-sharing arrangement. During

NASA's X-36 flight tests, Ames led the program, Boeing conducted the flight test operation and Dryden provided range and technical support. ✱

For more information, contact Michael Mewhinney at Ames Research Center. ✉ mmewhinney@mail.arc.nasa.gov Please mention you read about it in *Innovation*.

NEW AIR SAFETY AGREEMENT SIGNED

NASA and the Federal Aviation Administration (FAA) recently signed an agreement that establishes a new partnership in pursuit of improved aviation safety, airspace system efficiency, aircraft environmental concerns and affordable service. The agreement creates an executive board composed of senior managers from both agencies who will monitor progress and ensure that complementary aviation and commercial space transportation goals are achieved through a coordinated planning effort. The FAA will be more closely involved with NASA's aviation research program in developing innovative technologies, concepts and products to benefit U.S. aviation.

This is not the first time NASA and the FAA have coordinated activities. Previously, they have focused their research in developing technology to predict wind shear and to detect aging aircraft and aircraft icing. The establishment of a national safety goal by the White House Commission on Aviation Safety and Security set a course toward a series of complementary goals at both the FAA and NASA.

The FAA's mission is to provide a safe, secure and efficient global aerospace system that contributes to national security and U.S. aerospace safety. One of NASA's missions is to research, develop, verify and transfer advanced aerospace and related technologies. This research primarily focuses on the development of high-risk revolutionary technology advances that will be instrumental to the future success of the FAA and industry. ✱

For more information, contact Michael Braukus at NASA Headquarters. ☎ 202/358-1979, 📠 202/358-4060, ✉ michael.braukus@hq.nasa.gov Please mention you read about it in *Innovation*.

SMALL BUSINESS/SBIR

Wearable Computer in Prototype Stage

WORK IS SET TO BEGIN ON A PROTOTYPE for a wearable "computer-in-a-cube" using a new version of the proprietary chip-stacking technology currently aboard the Hubble Space Telescope as part of Hubble's new solid-state data recorder retrofit in February 1997.

The technology was developed through both the Defense Advanced Research Projects Agency (DARPA) and several NASA Small Business Innovative Research (SBIR) program contracts managed by NASA's Goddard Space Flight Center. It is being used to produce a voice-activated, wearable computer system to be worn as part of future battlefield combatant clothing. This development program supports the Advanced Humionics Platform (AHP), which is funded by DARPA and managed by the U.S. Army Soldier System Center.

The wearable computer's core, dubbed the "Independent Processor Module (IPM)," will be the size of a deck of cards. An integrated suite of electronics and sensors needed to cope with a wide array of operational and support needs is planned to include a battery, microphone and eye glasses' display with miniature camera under a separate contract with DARPA and the Soldier System Center. To support that goal, the IPM is being designed to weigh less than one-half pound and to blend into the clothing of military personnel so it will not interfere with any other equipment.

Irvine Sensors Corporation's proprietary Neo-stack™ packaging technology is being used for the development of a computer-in-a-cube for the IPM. Four such cubes per IPM would then provide the unit with workstation capability. The Jet Propulsion Laboratory and a subcontract from the Boeing Company developed the Neo-stack™ process in this project under a NASA Phase III SBIR contract.

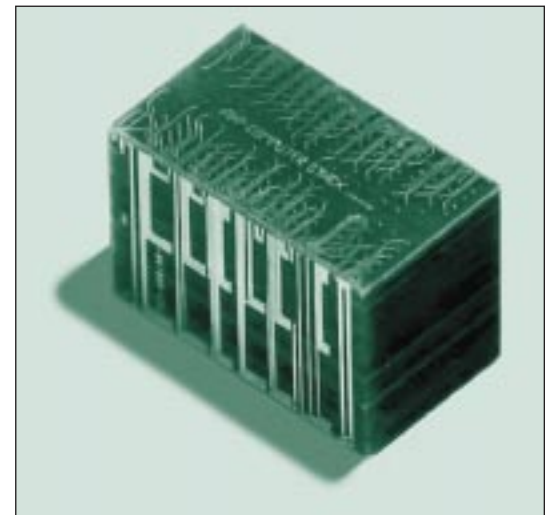
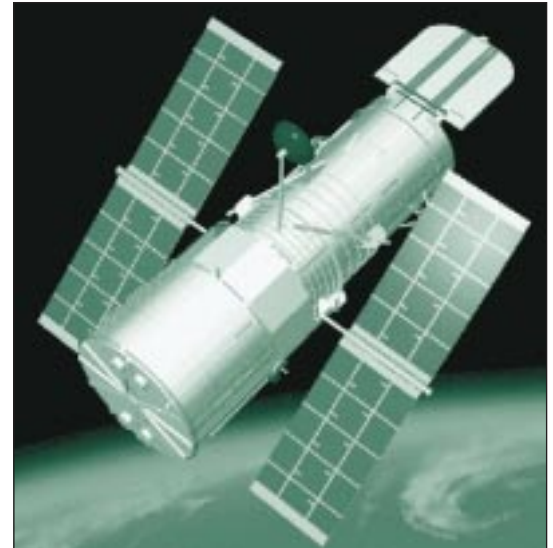
The stack technology allows different chips to be stacked together in the same stack as well as multiple chips per layer. The goal is to use the Neo-stack™ approach to integrate mass memory storage, an Intel StrongARM™ microprocessor, interconnection logic and an Institute of Electrical and Electronic Engineers (IEEE) 1394 communications interface for networking in a single cube. The original Irvine Sensors

three-dimensional proprietary chip-stacking technology was developed under several SBIR contracts, including several funded by Goddard. Irvine Sensors' DRAM Memory Short Stacks were the first chip-stack products to use the original chip-stacking process, and they are currently aboard Hubble.

Keith D. Gann, Irvine Sensors' Director of High Density Electronics, said, "Neo-stacking was conceived to accommodate chips of different physical dimensions in the same stack. This capability is expected to enable embedded complete systems where extreme miniaturization is necessary, such as the processing stacks for the AHP module. When multiple chips can be included in each layer with both varying functionality and a high level of interconnectivity, a wide variety of system applications will be possible. The process is being developed to facilitate manufacturing automation, a key factor in terms of costs."

Irvine Sensors Corporation, headquartered in Costa Mesa, California, is primarily engaged in the development and sale of high-density electronics, micro electro mechanical system (MEMS) sensors, sensor readout circuits, image processing devices, miniaturized cameras, electronic film systems, wireless infrared communications products, and low-power analog and mixed-signal integrated circuits for diverse systems applications. ✱

For more information, contact Keith D. Gann at Irvine Sensors. ☎ 714/444-8765, ✉ kgann@irvine-sensors.com Please mention you read about it in *Innovation*.



(Top) Several spinoff technologies have come from the Hubble Space Telescope, in this artist's rendering, including a chip stacking process that is being applied to a wearable computer system for combat use.

(Bottom) The core of a wearable computer is four of the Neo-stack™ computers-in-a-cube with workstation capability.

Shuttle Training Goes International

A TRAINING SYSTEM THAT RECERTIFIES Space Shuttle shop floor technicians at Kennedy Space Center is being used in an international training program for installing a seismic array network that monitors the Comprehensive Nuclear Test Ban Treaty. ENSCO, INC., of Springfield, Virginia, developed the Automated Recertification Training System (ARTS) under a Small Business Innovation Research (SBIR) project. The system reduces training time by 50 percent and improves test scores up to 20 percent for Kennedy's space flight operations contractor.

ARTS is an advanced computer-based training (CBT) system capability that uses multimedia technology and interactive courseware to increase the efficiency and cost-effectiveness of technical training applications. ENSCO Project Engineer Gaylen Drape said the ARTS program experience led to the creation of a training program for AlliedSignal Corporation, which is engaged in the installation of a seismic array network. Drape said the use of interactive multimedia technology will reduce training time and make seismic array systems easier to use and maintain. ENSCO's primary markets have been the development of CBT for military agencies and the aerospace industry, as well as the embedding of CBT applications within high-end scientific software systems.

NASA wanted the ARTS program to optimize critical and essential recertification training of shop floor technicians, according to NASA Engineer Tim Barth. Barth said that ENSCO provided Kennedy

Space Center with five pilot courses, transferring existing Kennedy classroom-based materials to CBT and developing software tools and templates to facilitate production and maintenance of CBT applications by personnel with limited programming experience.

Barth added that the Kennedy space flight operations contractor,

United Space Alliance, integrated ARTS concepts and methodologies in an operational Just-in-Time (JIT) computer-based training program, which is now extensively used by technicians and quality inspectors. The JIT program has contributed to improved processing efficiencies and job performance in Space Shuttle operations.

The ARTS program showed a reduction of training time of up to 50 percent using interactive courseware over classroom-based methods, with a 10- to 20-percent improvement in pre- and posttest scores. The use of production tools and templates reduced CBT development time from 30 to 60 percent, depending on the course's complexity. Further research showed that multimedia training courseware enhances learning and improves on-the-job performance. The use of an integrated development environment also streamlines the courseware production process, making courseware easier to develop and maintain. ✱

For more information, contact Lewis Parrish at Kennedy Space Center.

☎ 407/867-6373, ✉ ParriLM@kscgws00.ksc.nasa.gov Please mention you read about it in *Innovation*.

Review Gives Commercialization Help

A RECENT NASA TECHNOLOGY COMMERCIALIZATION Review (TCR) provided five Small Business Innovative Research (SBIR) contractors with an expert evaluation of their biomedical technologies to accelerate commercialization applications. NASA's Regional Technology Transfer Centers helped prepare the contractors to present their summaries at the review.

Coordinated by the National Technology Transfer Center (NTTC) on November 2 and 3, 1998, in Boston, Massachusetts, the review is geared toward helping promising NASA small business contractors take their technologies to commercial markets. Another purpose of the review is to bring these small businesses together with leaders in business, finance and research to help hone their commercialization plans.

The participating contractors received input on potential commercial applications, technology transfer feasibility, product strategies, financing, hurdles to overcome and potential solutions. The goal is to provide TCR participants with networking

Experience from creating computer-based training to recertify Space Shuttle shop technicians is being applied to training in a monitoring component of the Comprehensive Nuclear Test Ban Treaty. Technicians process a new Block 2A engine for the STS-88 mission aboard Endeavour, which flew December 1998.



opportunities, new ideas, feedback and assistance through expert referrals. Participating were representatives from Cybernet Systems Corporation of Ann Arbor, Michigan, DelSys, Inc., of Boston, Konigsberg Instruments, Inc., of Pasadena, California, The Technology Partnership of Grosse Ile, Michigan, and Advanced Optical Technologies, Inc., of East Hartford, Connecticut.

Paul Cobb, vice president of Technology at Cybernet Systems, said the review taught him the importance of choosing a specific market area on which to focus and how to find a partner that would be interested in commercializing his company's technology. Cobb's miniature portable physiological measurement and analysis system can collect medical data from a remote location and transmit it through very precise signals back to a central location. "It gave us some direction," Cobb said. "We definitely have a better understanding of the commercialization process."

Carlo De Luca, president of DelSys, said the review steered him toward a different market than he had initially planned, which was the type of information and guidance he had hoped to receive from the panel. DelSys develops and markets electrodes that scan the surface of muscles to detect, record and analyze electrical signals that emanate from muscles. The electrodes are noninvasive and do not require the use of conductive gel.



Carlo DeLuca (left), president of DelSys, and Ying Zhao (middle), vice president of Advanced Optical Technologies, were among five SBIR contractors who received helpful commercialization information at a recent NASA review and coaching from the Regional Technology Transfer Centers (RTTCs). Both were coached by Jim Dunn (right), co-executive director and CTO at the Northeast RTTC.

Networking to find commercial partners interested in long-term investment was the outcome sought by Bill Mills, the general manager of Konigsberg Instruments. His company's technology was designed under the SBIR program to give the Biomedical Engineering Office at NASA's Kennedy Space Center in Florida the ability to monitor the health and safety of launch pad workers during Space Shuttle fueling operations. The system, which could monitor eight direct current differential inputs, eight alternate current biopotential inputs, oxygen saturation, respiration, activity and core temperature, includes a two-voice communications channel. Mills said that his company needs to "break out of the box.

The panel has shed some light on some of the problems we will have in taking this to market. I came here to make the connections to do that."

"The review was good because it brought everything together for us," said David Bettinger, president of The Technology Partnership, whose company develops technology that relies on viscoelastic attributes of polymers for both continuous and on-demand drug dispensing. "It was an excellent review. And the reviewers did not blast us all to pieces."

The SBIR program awards contracts to small businesses in the United States to further research and develop their technologies to meet a NASA need. ✱

For more information, contact Carol Waris at the National Technology Transfer Center. ☎ 304/243-2417, ✉ cwaris@nttc.edu Please mention you read about it in *Innovation*.

SBIR PHASE II PROPOSALS SELECTED

NASA has selected 12 research proposals for negotiation of Phase II contract awards for NASA's 1998 Small Business Technology Transfer (STTR) program. A total of 45 Phase II proposals were submitted by contractors completing Phase I projects. All proposals were peer reviewed for both technical merit and commercial potential. The combined award total for the 12 Phase II contracts is expected to be \$6 million.

The STTR program is designed to stimulate technological innovation, help small businesses become better qualified to assist NASA in its research and development and increase private commercialization of federally funded research. The program also requires small businesses to conduct cooperative research and development by partnering with a research institution.

The STTR program management office is located at Goddard Space Flight Center, Greenbelt, Maryland, with executive oversight by NASA's Office of Aerospace Technology at NASA Headquarters in Washington, D.C. Individual STTR projects are managed by NASA's nine field centers. A listing of the selected companies and their research institution partners can be found at <http://sbir.nasa.gov> ✱

For more information, contact Carl Ray at NASA Headquarters. ☎ 202/358-4652, ☎ 202/358-3878, ✉ Cray@hq.nasa.gov Please mention you read about it in *Innovation*.



Technology Opportunity Showcase highlights some unique technologies that NASA has developed and which we believe have strong potential for commercial application. While the descriptions provided here are brief, they should provide enough information to communicate the potential applications of the technology. For more detailed information, contact the person listed. Please mention that you read about it in *Innovation*.

Hot NASA Technologies

Accelerometer and Integral Bar Graph Display

Johnson Space Center has an accelerometer and integral bar graph display consisting of four major components: accelerometer, display driver, bar graph display and threshold selector. Any commercially available accelerometer can be used to differentiate the output to eliminate any direct current offset. It is then rectified and filtered to provide a smoothed output proportional to the acceleration, which is then fed to a display driver, which turns on the display's segments according to the accelerometer signal's amplitude. Any single individual segment driver can be monitored to activate an alarm with an active driver. The threshold selector determines the alarm's acceleration level. An optically isolated output can be used for annunciation or control function. The device can analyze vibration in machinery, engines, vehicles and airframe structures and can be used for the emergency shutdown of rotating machinery and engine testing. The device is portable and self-contained to ground loop errors, and it comes with a power supply filter. ✱

For more information, contact James Cameron at Johnson Space Center.
☎ 281/483-1749, ☎ 281/244-8452, ✉ commercialization@jsc.nasa.gov
Please mention you read about it in *Innovation*.

System for Testing Bearings

Marshall Space Flight Center seeks to license to industry a system that provides manufacturers with a simple, reliable means of testing bearings under precise radial loads. These loads can be adjusted throughout the testing process to assess the effect of varying loads and to establish fatigue parameters. A pair of spaced bearings is used to support a shaft to mount the bearing to be tested. A bearing holder, spaced from the pair, has an annular collar positioned in an opening in the bearing holder. A screw threaded through the holder engaging the collar can be adjusted to move the collar out of alignment with the pair of bearings to apply a radial load to the bearing being tested. The system can be applied to any situation in which it is desirable to test bearings under critical conditions and various loads to assess durability and life span. ✱

For more information, contact Al Jordan at Marshall Space Flight Center.
☎ 256/544-6532, ☎ 256/544-3278. Please mention you read about it in *Innovation*.

Hybrid Butterfly Valve

Stennis Space Center seeks to partner with a company to develop a working prototype of the hybrid butterfly valve, with the possibility of licensing. The hybrid butterfly valve is a concept system, currently in the drawing stage, that combines the compactness, light weight and full flow capability of butterfly valves with the throttling and sealing advantages of globe and needle valves. It has less pressure drop and is simple to operate, compact in design and relatively low cost. The valve overcomes the limitations of traditional butterfly valves. A rotational motion and a translation motion are combined to obtain desired throttling and sealing actions. A stationary seat and a valve closure disk rotate a shaft that extends through a slot, supported by brackets. Guide members carried by the disk help ensure that the rotary and longitudinal motions occur separately and in correct sequence. The hybrid butterfly valve has commercial applications in chemical processing, natural gas processing and distribution and petroleum processing and distribution. ✱

For more information, contact Staci Kramer at Stennis Space Center.
☎ 228/688-2751, ☎ 228/688-3935, ✉ skramer@ssc.nasa.gov
Please mention you read about it in *Innovation*.

Mass Density Sensor

Langley Research Center seeks industry partners to license and cooperatively develop a commercial product using a new sensor technology. A nonintrusive, low-cost method has been developed for determining the resin content of textile materials during manufacturing. Novel to the sensor is the use of natural mechanical resonance in a moving resin-impregnated yarn or tow, which is held under tension. Vibration is then induced and sensed at the center of the supported span by an optical sensor, also unique to the sensor. Unlike the old-time consuming cut-and-weight method used today, this method is a continuous process operating at hundreds of feet per minute without requiring any interruption to the manufacturing process. Unlike elaborate electronic gauges, the invention is mechanically robust, easy to install and inexpensive, and it requires no special safety precautions. It measures mass density of filament or yarns, including nylon, polyester, synthetic yarns and optical fiber. ✱

For more information, contact Sherry Sullivan at Langley Research Center.
☎ 757/864-2556, ☎ 757/864-8314, ✉ s.l.sullivan@larc.nasa.gov
Please mention you read about it in *Innovation*.



NASA Field Centers

Ames Research Center

Selected technological strengths are Information Technologies, Aerospace Systems, Autonomous Systems for Space Flight, Computational Fluid Dynamics and Aviation Operations.

Carolina Blake (Acting)

Ames Research Center
Moffett Field, California 94035-1000
650/604-0893
cblake@mail.arc.nasa.gov

Dryden Flight Research Center

Selected technological strengths are Aerodynamics, Aeronautics Flight Testing, Aeropropulsion, Flight Systems, Thermal Testing and Integrated Systems Test and Validation.

Eugene (Lee) Duke

Dryden Flight Research Center
Edwards, California 93523-0273
805/258-3802
lee.duke@dfrc.nasa.gov

Goddard Space Flight Center

Selected technological strengths are Earth and Planetary Science Missions, LIDAR, Cryogenic Systems, Tracking, Telemetry, Command, Optics and Sensors/Detectors.

George Alcorn

Goddard Space Flight Center
Greenbelt, Maryland 20771
301/286-5810
george.e.alcorn.1@gsfc.nasa.gov

Jet Propulsion Laboratory

Selected technological strengths are Deep and Near Space Mission Engineering and Operations, Microspacecraft, Space Communications, Remote and In-Situ Sensing, Microdevices, Robotics, and Autonomous Systems.

Merle McKenzie

Jet Propulsion Laboratory
Pasadena, California 91109
818/354-2577
merle.mckenzie@jpl.nasa.gov

Johnson Space Center

Selected technological strengths are Life Sciences/Biomedical, Spacecraft Systems, Information Systems, Robotic and Human Space Flight Operations

Henry (Hank) Davis

Johnson Space Center
Houston, Texas 77058
281/483-0474
henry.l.davis@jsc.nasa.gov

Kennedy Space Center

Selected technological strengths are Emissions and Contamination Monitoring, Sensors, Corrosion Protection and Biosciences.

Gale Allen

Kennedy Space Center
Kennedy Space Center,
Florida 32899
407/867-6226
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Langley Research Center

Selected technological strengths are Aerodynamics, Flight Systems, Materials, Structures, Sensors, Measurements and Information Sciences.

Joe Heyman

Langley Research Center
Hampton, Virginia 23681-0001
757/864-6005
j.s.heyman@larc.nasa.gov

Lewis Research Center

Selected technological strengths are Aeropropulsion, Communications, Energy Technology and High Temperature Materials Research, Microgravity Science and Technology and Instrumentation Control Systems.

Larry Viterna

Lewis Research Center
Cleveland, Ohio 44135
216/433-3484
Larry.A.Viterna@lerc.nasa.gov

Marshall Space Flight Center

Selected technological strengths are Materials, Manufacturing, Non-destructive Evaluation, Biotechnology, Space Propulsion, Controls and Dynamics, Structures and Microgravity Processing.

Sally Little

Marshall Space Flight Center
Huntsville, Alabama 35812
256/544-4266
sally.little@msfc.nasa.gov

Stennis Space Center

Selected technological strengths are Propulsion Systems, Test/Monitoring, Remote Sensing and Nonintrusive Instrumentation.

Kirk Sharp

Stennis Space Center
Stennis Space Center, Mississippi
39529-6000
228/688-1914
kirk.sharp@ssc.nasa.gov

NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint sponsored research agreements and incubate small start-up companies with significant business promise.

Joseph C. Boeddeker

Ames Technology Commercialization Center
San Jose, CA
408/557-6789

Lyn Stabler (Acting)

Mississippi Enterprise for Technology
Stennis Space Center, MS
228/688-3144

Wayne P. Zeman

Lewis Incubator for Technology
Cleveland, OH
216/586-3888

Thomas G. Rainey

Florida/NASA Business Incubation Center
Titusville, FL
407/383-5200

Judy Johncox

University of Houston/NASA Technology Center
Houston, TX
713/743-0451

Kirk Wiles

Business Technology Development Center
Huntsville, AL
256/704-6000

Kathleen Weiss

Maryland Economic Development Corp.
Greenbelt, MD
800/541-8549

Van Garner

California State Polytechnic University-Pomona
Pomona, CA
909/869-2276

Martin Kaszubowski

Hampton Roads Technology Incubator
Hampton, VA
757/865-2140

Small Business Programs

Carl Ray
NASA Headquarters
Small Business Innovation Research Program (SBIR/STTR)
202/358-4652
cray@hq.nasa.gov

Paul Mexcur

Goddard Space Flight Center Small Business Technology Transfer (SBIR/STTR)
301/286-8888
paul.mexcur@pop700.gsfc.nasa.gov

NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D and foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the RTTC nearest you, call 800/642-2872.

Ken Dozier

Far West Technology Transfer Center
University of Southern California
213/743-2353

Dr. William Gasko

Center for Technology Commercialization
508/870-0042

J. Ronald Thornton

Southern Technology Applications Center
University of Florida
352/294-7822

Gary F. Sera

Mid-Continent Technology Transfer Center
Texas A&M University
409/845-8762

Lani S. Hummel

Mid-Atlantic Technology Applications Center
University of Pittsburgh
412/383-2500

Christopher Coburn

Great Lakes Industrial Technology Center
Battelle Memorial Institute
440/734-0094

Joseph P. Allen

National Technology Transfer Center
Wheeling Jesuit University
800/678-6882

Doris Rouse

Research Triangle Institute Technology Applications Team
Research Triangle Park, NC
919/541-6980

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Go to **NASA's Commercial Technology Network (CTN)** on the World Wide Web at <http://nctn.hq.nasa.gov> to search NASA technology resources, find commercialization opportunities, and learn about NASA's national network of programs, organizations, and services dedicated to technology transfer and commercialization.

MOVING FORWARD

Events

The *1999 National Space Symposium*, April 5–8, 1999, Colorado Springs, Colorado, is widely regarded as the premier annual space forum, featuring top national and international speakers addressing critical civil, commercial and national security space issues. The theme, “Space: Advancing Our World,” will be emphasized from a totally integrated approach reflecting the state of today’s space industry. In addition to the professional sessions, the symposium boasts the most comprehensive exhibit hall of aerospace solutions, an entertaining and enlightening opening ceremony and corporate partnership and workforce of the future luncheons. It will culminate with the gala Space Technology Hall of Fame dinner. To register, call 719/576-8000, or visit <http://www.spacefoundation.org/>

Novel Concepts for Smaller, Faster and Better Space Missions, April 19–21, Redondo Beach, California, is an international specialists symposium organized by the International Astronautical Federation (IAF), Microcosm Inc., Orbital Sciences Corporation and the Jet Propulsion Laboratory. The symposium will focus on novel concepts and mission opportunities along with the enabling system design features of small satellite missions for commercial, scientific, educational and other applications. There will be six sequential technical sessions containing more than

40 papers by specialists from government agencies, private industry and universities. A number of present and planned mission concepts will be presented, ranging from niche data messaging services via privately financed science projects to novel university initiatives. Panel discussion sessions are also planned. For more information concerning registration, please call the IAF Specialists’ Symposium at 310/216-6772, or visit <http://www.iafastro.com/seminars/novel99/novel99.htm>

The *Global Air & Space ’99 International Business Forum and Exhibition*, May 3–5, 1999, Arlington, Virginia, will feature senior government and commercial aerospace industry leaders sharing experiences related to the forum’s theme, “Working Together Globally.” They will also discuss and debate critical business and policy issues facing the world today in aerospace, aviation and communications. Topics will include: Space—The Commercial, Scientific, and Security Enabler; Civil Aviation—The Economic Engine That Creates and Expands Global Markets; and Global Security—Needs for the New Millennium. To register, complete the registration form found at <http://www.aiaa.org/calendar/global99prog.html> and fax it to 703/264-7657. For more information, contact the American Institute of Aeronautics and Astronautics by calling 703/264-7500. ✱



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